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March-April 1951

# METAL TREATING

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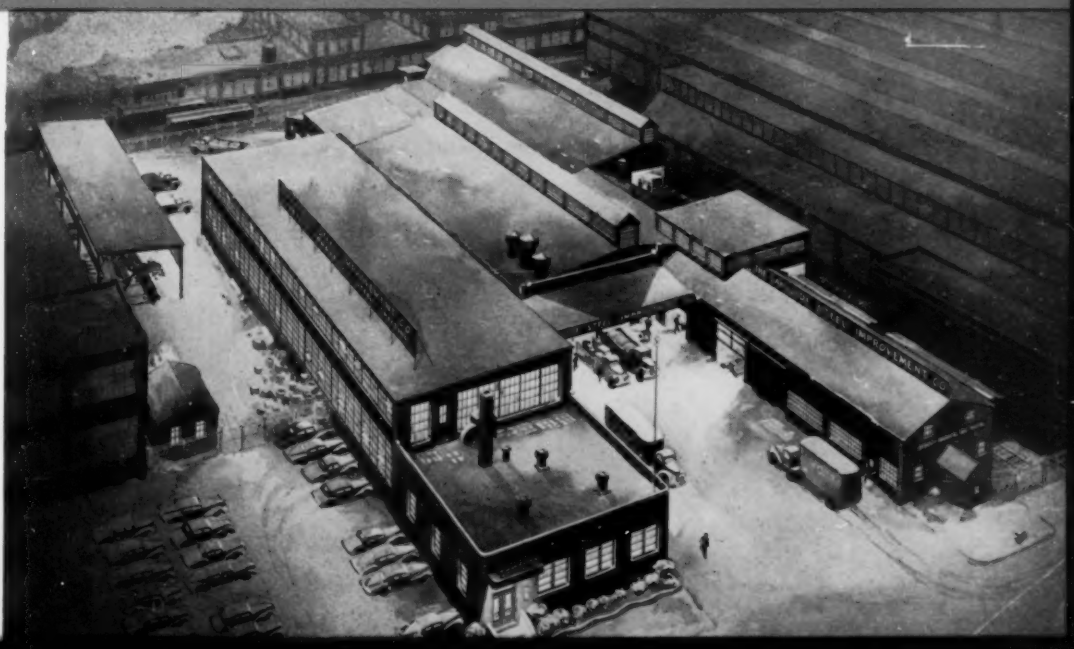
METAL TREATING INSTITUTE

## JOURNAL OF THE METAL TREATING INSTITUTE

*National Trade Association of*

## COMMERCIAL HEAT TREATERS



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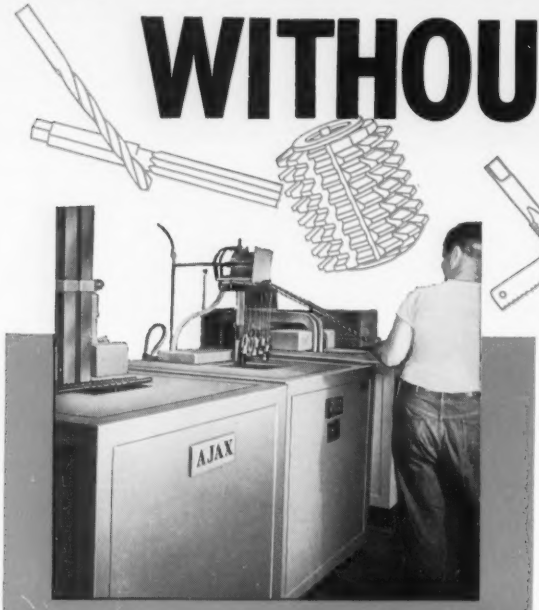


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# METAL TREATING

*Official Journal of the Metal Treating Institute*


## *Editorial...*

### A NEW CIRCULATION POLICY

Because of the interest shown in METAL TREATING which is now the only magazine devoted exclusively to industrial heat treating and its equipment, services and functions in industry—the Metal Treating Institute has established a new circulation policy. Beginning with this issue the magazine will be sent without charge to not only all commercial heat treating plants, but to a selected list of those manufacturing plants who perform industrial heat treating operations as a departmental function.

The subject of metal treating is in itself of such vital interest, particularly under today's production conditions, that the Institute is particularly desirous of being of real assistance to *all* users of heat treating operations. Heat treating equipment, materials and operational skills today are more vital than ever.

With this in mind METAL TREATING will have as its objective the advancement of the art and industry of heat treatment of metals and will continue to publish technical information, articles on improvements in heat treating practice, news of the heat treating industry, abstracts of manufacturers' literature and the latest developments in materials and equipment.

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# Manufacturing Applications of Liquid Impact Blasting

*By* B. H. MARKS, *Manager*
*Hydro-Finish Division*
*Pangborn Corporation*
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*Editor's Note:*

*This is an abstract of a paper presented jointly by Mr. Marks and Mr. A. L. Gardner, Advertising Manager of the Pangborn Corporation, during the ASTE convention. Past-President Fred Heinzelman, Jr., had been invited to present his comments from a user's standpoint and these are presented at the end of the article.*

The application of liquid impact blasting equipment is as broad as industry itself. Those who have installed the equipment are continuously finding new uses. In developmental experimenting, specimen parts are being blasted which are so large they must be handled with a crane; other parts are so small they must be handled with tweezers.

A classic example is the wet blasting of Bibles for a publisher and binder. The purpose was to blast the edges of the pages to improve the bonding of gold leaf. At first thought, this seemed highly impractical, but the publisher brought these books to us with the pages clamped together under about 400 psi pressure, the edges having been previously sanded. The blasting proved very satisfactory and the water did not tend to wet the edges of the paper under this condition.

The usefulness of liquid impact blasting to tool engineers is based on three fundamentals: (1) Improved quality of product; (2) Reduced cost through labor saving; (3) Increased production. (*The same of course applies to the heat treater—Ed.*)

Liquid impact blasting, which we call Hydro-Finish, has found its place in industry largely through the tool engineer's alertness to the adaption of new processes.

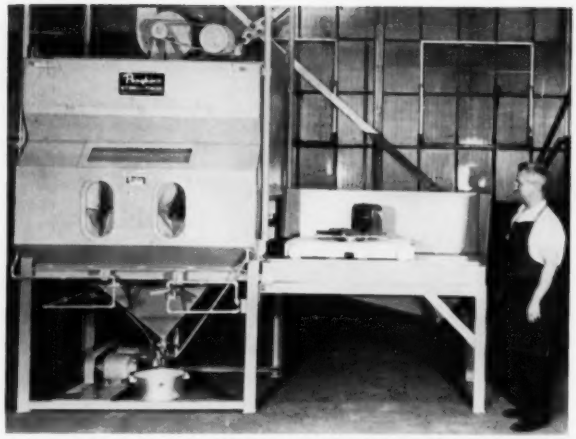
It is useful to review the general methods by which any abrasive impact system works:

(1) *Suction Feed*—The blast gun connects with two feed lines, one for compressed air and one for abrasive. This gun is very similar in principle to an ejector pump. Compressed air passing through the nozzle creates a partial vacuum, which lifts the abrasive to the gun and then drives it forward at high velocity.

(2) *Direct Pressure*—In this type of unit the abrasive is contained in a pressure vessel and forced to the blast gun by compressed air, usually at 80 to 90 psi.

(3) *Centrifugal (Airless) Blasting*—In equipment of this type, the abrasive is fed through the center of a rotating paddle wheel and is thrown by centrifugal force along the vanes at high velocity.

Each of the above methods has its own best applications. At present, most liquid blasting uses the suction feed method or a modification of this method where the abrasive is fed to the blast gun at low pressure. The latter offers greater blast efficiency since all the energy of the compressed air is used in propelling the abrasive and none of it is consumed in lifting the abrasive to the blast gun.



**Hydro-Finish cabinet with accessory track and loading car equipped with bearing mounted turn-table.**

NATURE AND USES OF THE PROCESS—Liquid blasting is a modified form of impact blasting whereby abrasive is suspended in a liquid, agitated to maintain suspension, and propelled through the blast guns by means of compressed air or other gas. Since the abrasive is suspended in a liquid (usually water plus a corrosion inhibitor), there is no limit to the fineness of the particles that can be used, but they are generally in the talcum powder range and finer.

This contrasts with the definite particle size control needed in a dry blast system because (1) Fine dry abrasives tend to pack tightly and flow unevenly; (2) Fine dry abrasives naturally create dust and an effective control provision is required, and (3) Surface finish produced by a fine dry abrasive is not as smooth as that produced by the same abrasive blasted in suspension with water using same pressure and volume.

Historically, liquid blasting is not a new process. The file manufacturers have used this process for many years in sharpening files. In the main however, industry paid little attention to surface finish until recent years. The modern use and study of this method began around the period of World War II, along with the need to mass produce precision items. Industry had to search for new means which would replace tedious, slow, costly hand finishing methods. It was then that liquid blasting came into general acceptance.

Liquid blasting is most generally adaptable to the following uses:

(1) Removing and blending directional grinding lines.
(2) Removing hardening oxides and discolorations.
(3) Improving lubrication retention.
(4) Preparing surfaces for electro-plating.
(5) Mold and die maintenance.
(6) Improving cutting tool life and appearance.
(7) Deburring.
(8) General maintenance cleaning.

The above uses may be profitably considered from the point of view of two basic classes:

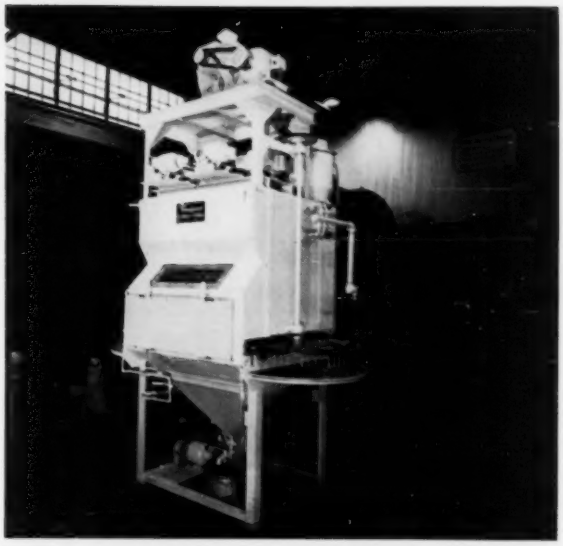
(1) Tool room use as an aid to production.
(2) Use for production line.

*Tool Room Applications*—For this type of work, a manually operated cabinet is recommended, since the work loads are variable. The chief interest is in producing good finishes while eliminating tedious hand work. For such tool room work consider the first six items on the above list of uses.

As a specific example, consider a die-casting die. A die of this type will be well fitted to most of the applications listed. Many people in the die casting field have been using liquid blasting equipment successfully for years.

(1) In the making of a die cavity or core, it is well to do as much polishing as possible before hardening, then liquid blast to blend and remove the grinding and directional polishing lines left on the surface. By blasting, the finish can be considerably improved. It is often necessary for the material being fabricated by the die-casting die to travel over the die surface in a direction perpendicular to the direction in which this surface was machined and polished. By improving the surface finish and producing a non-directional surface the resistance to such flow is reduced. Also, by liquid blasting, it is possible to reach many places difficult to reach in hand polishing.

**Special Hydro-Finish for cleaning fluted textile rolls. (Door open showing bank of nozzles.)**



**Special Hydro-Finish. Table turns 1⅓ R.P.M. for semi-automatic handling of small parts.**

It is important to remember that the finish obtained by liquid blasting is a function of the finish *before* blasting. Liquid blasting will not make a rough ground piece smooth enough to do the work of a finish ground piece. A good die can be made better, but little to improve a badly finished, malfunctioning die. Also, liquid blasting should not be thought of as a tool for producing a given dimension. In other words, a part should be finished to dimension *before* blasting, then blasted with an abrasive fine enough to hold that dimension.

(2) After hardening, the die can be blasted to remove the oxides which develop. In one reported case a die casting company required approximately sixteen man hours of labor to hand polish sixteen small inserts. Using liquid blasting, the processing time for these same pieces was reduced to less than one hour. The inserts were used in making a small serrated knob for a home appliance. The cavity was about ¾-in. deep, ⅜-in. diameter at the bottom and tapered to about ½-in. diameter at the top. The many serrated grooves running from top to bottom made this piece difficult to polish by hand. The report further stated that the die produced good hardware finished parts almost immediately, whereas a normal hand polished cavity of this type required considerable break-in time before producing good parts.

(3) Surfaces which have been liquid blasted with fine abrasive contain many microscopic wells. A surface of this type retains lubrication very satisfactorily. There is reason to believe that drawing dies treated in this manner will hold the drawing compounds more satisfactorily and thus better resist galling and scoring.

(4) Many reports have been received on the part liquid blasting has played in improving the quality

of plating. Reported improvements include: (a) Removal of grinding fuzz in order that plating adheres only to base metal; (b) Removal of small bits of smudge which may cause gassing in the plating tank and result in a bad plating job; (c) Provision of smooth plating build-up around corners and sharp edges; (d) Provision of same surface conditioning effects as mentioned previously.

(5) Liquid blasting has a major application in the maintenance of dies and molds after they are placed in service. This is an especially critical item with manufacturers who use molds and dies which operate at high temperature and require periodic maintenance, such as die-casting dies, rubber molds, glass molds, forging dies and others. There is nothing more disheartening than to see a once beautifully finished die of this type in the hands of a cleaning room man who is likely to attack the problem of removing carbon from a ten micro-inch surface with the first rasp or scraper available. It is useless to place highly polished surfaces on a die or mold if they can not be maintained in cleaning. Liquid blasting has been invaluable in answering this requirement. Due to the fine abrasive used, repeated cleanings can be accomplished with a minimum of metal removal and at the same time leave a surface on the die or mold equivalent to the original.

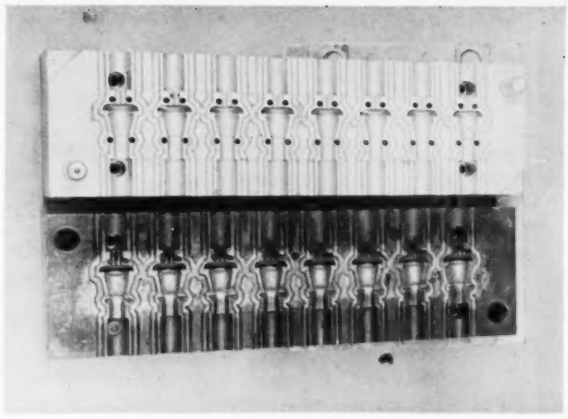
In addition to the previously cited advantages of cleaning die-casting dies, liquid blasting provides rapid cleaning with semi-skilled labor, reduces break-in time, eliminates disassembly in many cases, and permits more thorough parts inspection after cleaning.

(6) The use of liquid blasting as a means of finishing cutting tools is a subject of considerable controversy. Liquid blasting is not a "cure all," however, many companies have found that production cutters blasted after grinding have shown considerable increase in tool life.

Machinists will agree that if they hand stone a cutter after grinding, it will last longer. It is believed that in the main approximately the same thing is accomplished when liquid blasting a cutter that the machinist does when he hand stones it. The main difference is that it is impractical for a machinist to hand stone a complicated cutter such as a hob or a broach, due to the time consumed, while it is an easy and quick job to liquid blast cutters of this type. Reliable data on the subject of increased tool life can only be gained by statistical evidence.

LIQUID BLASTING ON THE PRODUCTION LINE—Blasting advantages mentioned earlier are the same for production parts as for die and mold parts.

In some cases, manually operated equipment is sufficient to meet production requirement, but many times it is necessary to design automatic or semi-automatic machines. This has recently been done for one of the automotive manufacturers who will use liquid blasting to remove carburizing smudge from ring and pinion gears. This will require four rotary indexing table machines, each finishing in the neighborhood of 700 pieces per hour.



**Two halves of a rubber mold before (bottom) and after (top) being subject to liquid blasting.**

Also, there have been designed and built several inclined, parallel roll machines for processing round work of various types. Several of these were installed by textile machine manufacturers for improving the finish on fluted spinning rolls. After the rolls leave the liquid blast machine, they are checked by passing absorbent cotton over the surface of the roll. There can be no pick up of cotton fiber on the finished surface. One manufacturer of these rolls stated that he would eliminate five automatic honing and hand stoning operations with the use of liquid blasting. This same machine has received very favorable consideration by the automotive manufacturers, who have the problem of processing automatic transmission control valve plungers. This type of equipment is being considered for the removal of the feather edges which are left after centerless grinding.

Several other automatic table machines have been built for the processing of television parts, and liquid blast tumbling barrels are available for blasting small parts by a batch handling method.

Many other blasting arrangements have been designed. However, in the main, they amount to nothing more than a method of automatically presenting the work for blasting and removing it from the blast stream for further handling.

It must be remembered that liquid impact blasting deals with the application of very fine abrasive material. It is, in a sense, a "finish grinder," and is primarily intended for processing finished, not raw, material. It would be as inefficient to use this finishing method for rough work as it would be to grind a rough casting to finish size when intermediate turning machines are available to do the job economically. Liquid blasting has many valuable applications, but generally it must be properly adapted to each intended job.

## *Comments on the*
## MANUFACTURING APPLICATIONS OF LIQUID IMPACT BLASTING

*by* FRED HEINZELMAN, JR.
*Fred Heinzelman & Sons, New York City*

Liquid blasting has many more applications than Mr. Marks has mentioned. As a matter of record, some of the applications are in no way related to any tool engineering problems; nevertheless they are of major importance to the industries requiring a method of enhancing their products and articles.

For the present let us consider liquid blasting generally adaptable to the uses Mr. Marks mentioned. Removing and blending directional grinding lines undoubtedly has been a great source of trouble in the manufacture of special machine and accurate instrumentation parts. The methods used for this heretofore, generally consisted of hand or mechanical honing and polishing. Liquid blasting has successfully eliminated these procedures on many ferrous materials. In one particular application it has not only removed fine machining marks, without a dimensional change, but actually imparted a finish of almost 5 to 6 microinches on aluminum parts manufactured by one of the local aircraft instrument companies. In another application it removed directional grinding marks that had detrimentally effected the fatigue values of a special machine part.

As a means of removing hardening oxides and discolorations on ferrous and non-ferrous, cast or machined, plastic dies or die casting dies, it has no equal. It is an excellent and rapid means of imparting a clean finish to the articles. It must be understood that the oxides and discolorations are those that are the result of proper heat-treatment and not a heavy heat-treat or forging scale. In these latter cases, sand or grit blasting is the proper tool. A great many plastic and die casting dies require no further polishing after liquid blasting, and are ready for production insofar as finish is concerned.

Some die casting dies, after heat-treatment and liquid blasting, are nitrided for longer production life. Occasionally the dies are nitrided without thought of removing the heat stains and metallic residues in the mold cavities, resulting from the test run previous to nitriding. This is poor practice from a nitriding point of view. It is imperative that these stains and residues be removed prior to nitriding, and liquid blasting does an admirable job.

Lubrication retention on castings generally gives the tool engineer less cause for trouble than on highly finished parts. Mechanical honing or polishing leave directional lines no matter how minute, and the lubricant has the tendency to flow along these lines. Liquid blasting prevents such a flow, due to the fact that the surface is actually pockmarked with microscopic craters homogeneously scattered over the surface of the part. Each of these craters will act as a small well of lubricant, very much the same way dispersed graphite flakes act in cast iron.

Although liquid blasting is not designed as a substitute for the comparatively economical method of pickling the materials in the proper acids and cleaning agents, prior to plating it, has various successful applications. Parts that have corroded surfaces are very rapidly cleaned and blend with the surrounding areas so well, that plating difficulties are eliminated.

The maintenance of dies and molds operating at high temperatures has been a major and time consuming operation to manufacture, for a good many years. Liquid blasting dies and molds of this type is an everyday occurrence in many companies throughout the U. S. There are reports that die maintenance has been reduced from forty hours to slightly less than two hours on one particular die.

Liquid blasting as a means of enhancing the appearance of twist drills and cutting tools is common practice and is primarily a sales promotion item. How effective liquid blasting is as a means of increasing tool life, is difficult to determine. Statistical reports are not readily available, but the blasting does remove the fine feather edges that result from grinding. Dental burrs are a good example of what can be accomplished by the removal of the feathery burrs due to liquid blasting. Any burrs heavier than a few tenths of a thousandth cannot be removed economically. Non-ferrous materials are much better suited for this process, particularly the magnesium and aluminum alloys. Not only does it remove burrs difficult to remove by any other means, but blends all fine directional tooling marks.

One of the unusual uses to which liquid blasting has been of value, is in the conditioning of plastic cavities for the manufacture of dolls. The cavities, ferrous or non-ferrous alloys, are very heavily blasted so the resulting molded part has a dull mat finish, similar to the texture of human skin. Another experiment is now in process of imparting a skin-like appearance to special nylon plastic compounds used in the development of artificial limbs. An aircraft propeller housing, after finish machining and inspection, is liquid blasted in designated areas to enhance the appearance of the item. An iron nickel alloy reed, anneal at 1850°F on one end only, is liquid blasted to remove the oxide so that subsequent spot welding is possible. Be-Cu molds are heat-treated and then cleaned by blasting, rather than pickling, or using expensive atmosphere control equipment to prevent oxidation during heat-treat processing. Aircraft plastic panels are blasted to remove the high luster generally associated with plastic molded parts. The dull mat finish diffuses reflections and prevents glare, a very important factor in today's aircraft design. These are just some of the applications that tool engineers have used on their jobs. Undoubtedly its use is not limited to ferrous or non-ferrous materials, to the plastic industry, or the tool engineer. Liquid blasting is another tool for industry; unskilled labor can be employed successfully on the most delicate parts with minimum cost or risk.

# Engineering Properties of Iron Castings Can Be Improved By Heat Treatment*

by C. E. Herington

*Concluded from* January-February Issue

## ANNEALING FOR STRESS RELIEF

Turning now to the first of the list of treatments; namely, annealing for stress relief, this is of course a common treatment and has almost entirely superseded the old method of aging or weathering. Obviously, since it is necessary to retain the structure of the metal, temperatures must be kept below the "critical," with the temperature and time of the annealing treatment depending upon the size and form of the casting. Higher strength Meehanite† metals require a somewhat higher temperature as indicated in Fig. 5.

| Recommended Temperatures For Stress Relief | |
|---|---|
| Type Meehanite | Temperature °F. |
| GE--GD | 950--1000 |
| GC--GB | 1050--1100 |
| GA--GM | 1100--1150 |

| Recommended Temperatures for Improved Machinability | | |
|---|---|---|
| Type | Low Temperature Anneal °F. | High Temperature Anneal °F. |
| GE--GD | 1220--1260 | 1550 |
| GC--GB | 1230--1270 | 1570 |
| GA--GM | 1250--1290 | 1580 |

Fig. 5

It might be pointed out that it is always good practice to heat a Meehanite casting slowly and evenly up to the temperature required. As soon as this point is reached a slow cooling cycle should be started at once.

## ANNEALING FOR MACHINABILITY

The lower half of Fig. 5 reveals similarly the proper temperatures of the low and high temperature anneals of the various materials. These anneals are, of course, for improved machinability, the low being below the "critical"; the high above the critical range. When using the high temperature treatment it is recommended that the castings he heated slowly to around 1200°F and then allowed to soak at this temperature long enough to assure uniform heating throughout. Temperature may then be raised rapidly or the casting may even be transferred to another furnace which had previously been heated to maximum temperature. These slight precautions will contribute a great deal toward eliminating thermal shock and possible cracking.

**Effect of drawing temperature on the hardness of Meehanite GA quenched from 1600°F in water or in oil.**

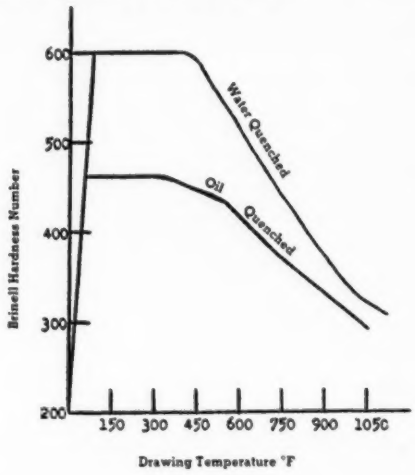



Fig. 6

## QUENCH FOR HARDNESS

With regard to the third treatment; namely, heating and quenching for hardness, most of the general engineering types of the material are closely comparable to carbon steels in their reaction to hardening by quenching in water or oil from above the "critical." In such cases, after soaking at around 1100°F, the temperature is raised to about 1600°F and the casting is then ready for hardening by quenching in oil or in water. With the exception of very simple and uncomplicated castings, it is generally preferable to quench in oil or warm water so as to minimize the chances of cracking. It follows, of course, that the more drastic the quenching the greater possibility of internal stresses being created which might result in cracking. For this reason it is advised that the casting be with-

*†The name MEEHANITE is a registered trademark.*
**Adapted from the December 1950 "Materials & Methods" article of the same title.*

drawn from the quenching medium while still smoking (about 250°F) and transferred immediately to a furnace for the drawing or tempering operation.

The chart (Fig. 6), shows the effect of the drawing temperature on the hardness of Meehanite type GA (50,000 psi as cast) from 1600°F in water or in oil.

Note that drawing temperature should not greatly exceed 400°F to 450°F if maximum hardness is required. It is also important that the casting be soaked at 400°F for one hour after it has reached that temperature and then cooled in air.

## MARTEMPERING

A relatively new method of accomplishing practically the same thing is the treatment known as martempering which transforms the structure to what is described as a "martensitic" structure. The advantage provided by this method is that it is much less severe in creating internal strains. The casting is quenched rapidly from above the "critical" by submerging it in a liquid bath and held at a temperature of about 500°F. It is held in the bath only until the casting has reached the same temperature as the quenching medium. It is then withdrawn and cooled in air. Generally a low temperature draw may be used to further reduce any tendency toward cracking, particularly if the casting shape is intricate.

**Effect of drawing temperature on the tensile strength and impact of Meehanite GA quenched from 1600°F in water or oil. The effect of such treatment on Meehanite GE is also indicated.**

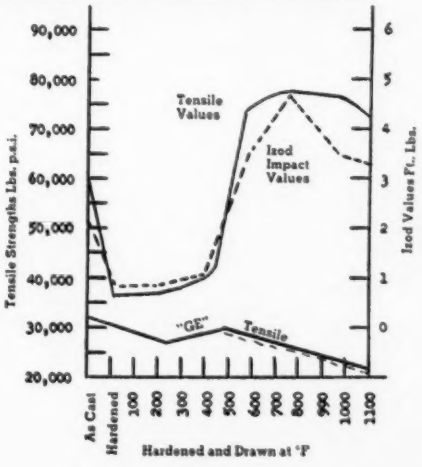



Fig. 7

Similarly Fig. 7 shows the effect of drawing temperature on the tensile and impact strengths of the same material. This illustration also shows that the lower strength, high carbon materials, of which Meehanite type GE with an as-cast tensile of 30,000 psi is typical, may actually be weakened by a quench and draw treatment.

## INTERRUPTED QUENCH

The fourth treatment adaptable is described as interrupted quenching or occasionally austempering. Briefly the process consists of holding the casting above the "critical" at about 1600°F until it is uniformly heated and then plunging it rapidly in a liquid salt or a lead bath which is held at a temperature range between 500° and 900°F. Lower temperature baths provide structures practically as hard as the conventional quench and draw but considerably tougher. Higher bath temperatures give a softer structure.

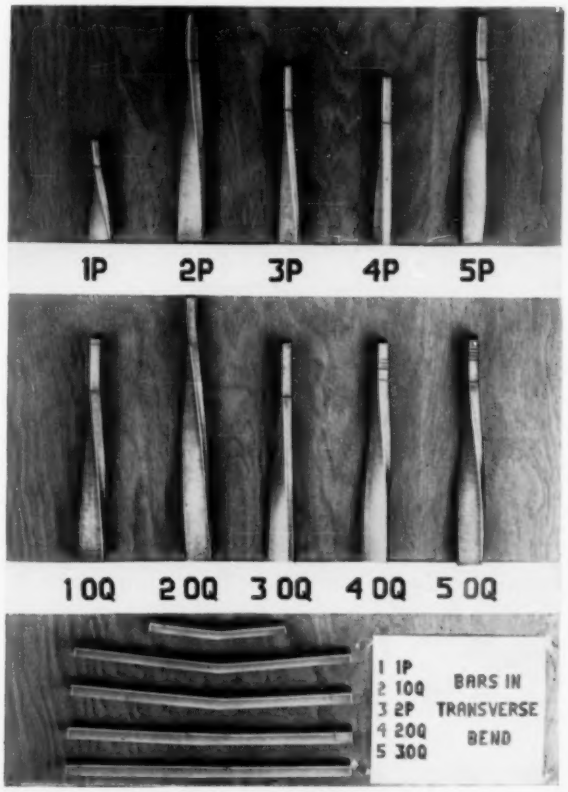



**Fig. 8 — Evidence of the ductility which can be achieved through spheriodizing treatment is shown on these test specimens.**

## SPHEROIDIZING

The fifth treatment is the somewhat lengthy process which imparts ductility to the material. This is known as spheroidizing in which the casting is submitted to a prolonged heating at a temperature below the "critical" point. Experiment has determined that 1300°F is the minimum for the higher types of Meehanite metal with the maximum results being obtained by holding it at this temperature for five hours upward.

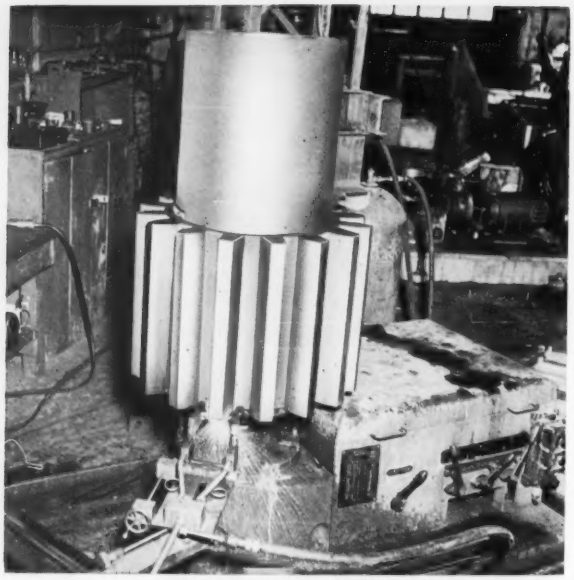


Fig. 9—Flame hardening 3000 lb. pinion.

The amount of ductility which can be achieved by this method is well illustrated in Fig. 8. This treatment, however, gives hardness only in the range of about 180 Brinell. The practical aspects from the application standpoint of the resulting material have not been fully exploited.

## FLAME HARDENING

Local flame hardening, where facilities are available, has been applied to many types of Meehanite castings and the results have been definitely beneficial and worthwhile.

With this method the zone of maximum surface hardness obtained is usually ½ to ¾ of the total depth of the case and is file hard. The success of the flame

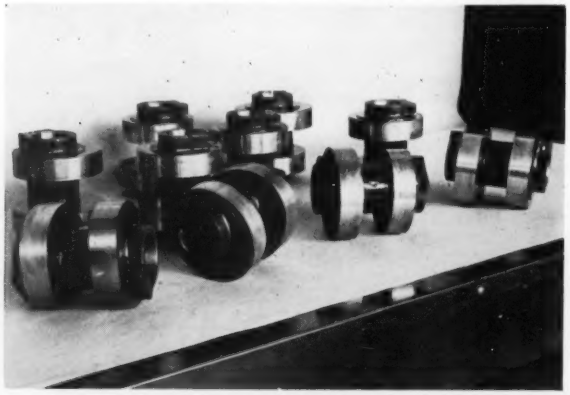


Fig. 10 — Heat treated cams provided a long wearing, hard surface.

hardening operation is, of course, basically dependent upon the uniformity, density and constitution of the material and that is why there has been comparatively little of this type of work applied to the average gray iron casting.

Fig. 11 — Heat treated ram and ram tip for a hydraulic briquetting press. Both high strength and toughness required.

A few selected illustrations show a number of rather interesting castings and indicate the treatment applied to them. A cement mill pinion (Fig. 9), weighing about 3000 lb., is being flame hardened to give added wear resistance to the teeth. This pinion replaced a cast steel unit.

The cams shown in Fig. 10 are a good example of an application requiring both abrasion resistance and toughness in combination with machinability. They were heat treated to 1600°F and quenched and drawn one hour at 400°F after machining and grinding. Cam surface thus achieved a hardness of about 575 Brinell.

Fig. 11 shows two parts, the ram and ram tip, for a hydraulic briquetting press. Both castings replaced a heat treated steel forging and both were oil quenched from 1600°F and drawn at 1000°F for three hours. This treatment provided tensile strength above 70,000 psi and a Charpy of around 8 ft. lb.

The Meehanite worm and shaft shown in Fig. 12 (top) are cast as a single unit and the part is used for a heavy-duty drive on a sugar refining pulp press. It replaced a heat treated SAE 3250 steel forging. The heat treatment on this casting resulted in a 78,000 psi tensile and a Brinell of 350. Here again the treatment consisted of quenching in oil at 1600°F and drawing at 1000°F.

A rather unusual application is shown in Fig. 13, for generally thread gages of all types are made from tool steel. In production these gages are preheated after rough machining operations to a temperature of

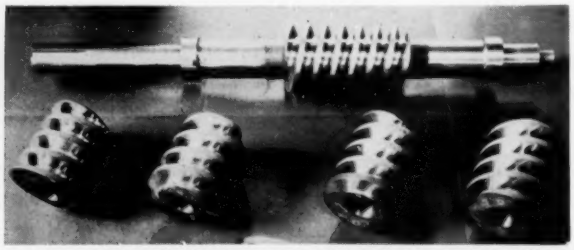


Fig. 12 — Various Meehanite worms subjected to quench and draw operations to achieve tensile strength of 78,000 psi and Brinells of 350. The worm and shaft (top) is a single casting.

**Fig. 13 — Thread gages produced in Meehanite metal made possible only by the assurance of uniform heat treating results.**

1200°F and transferred to a high speed furnace and brought up to a temperature of 1600°F. They are then quenched in cool oil. No drawing operation is required.

After heat treating, centers are lapped and the gages finished ground to the major thread diameter. Finally, the threads are rough and finished ground.

There seems little question but that in spite of the evidence of the benefits available through the proper application of various heat treatments to iron castings, that neither the specifying engineer nor the producing foundrymen have given proper attention to the subject. Modern foundries utilize up-to-date production equipment and manufacturing controls yet frequently fail to study properly customer design and property problems. Similarly, engineers and production men frequently fail to give thought to what can be achieved through the use of the facilities of commercial heat treating organizations. As a result of these double oversights, production time and product quality may be sacrificed or improper material selection may be made.

## Metal Treating Institute Members Have Standard Liability Policy

*Editor's Note:*

*The January-February issue of "Metal Treating" carried a review of the recommendations of a committee on policy with regard to liability of the heat treater as proposed by the Detroit Metal Treaters' Association. Because of the general interest in this subject, the standard policy adopted by Institute members is stated below.*

It is generally recognized that even after employing all the science known to us, and capable men with years of training, there still remain hazards in heat treating. Therefore, our liability to our customers shall not exceed our charges for the work done on any material, except by written agreement. Warranty will be assumed by us only when made in writing and signed by both you and us. In such event a higher charge will be made for our services. No claim for shortage in weight or count will be entertained unless presented within five (5) working days after receipt of materials by customer. No claim will be allowed for shrinkage, expansion, deformity, or rupture of material in treating, except by written agreement as above nor in any case for rupture caused by subsequent grinding. Whenever we are given material with detailed instructions as to treatment, our responsibility shall end with the carrying out of those instructions. Failure by a customer to indicate plainly and correctly the kind of material (i.e., make, brand and grade of steel) to be treated, shall cause an extra charge to be made to cover any additional expense incurred as a result thereof. No agent or representative is authorized to alter these rules and conditions, except by writing duly approved by us.

Formally adopted by the Metal Treating Institute.

## LAST CALL—1951 SPRING MEETING

If you have not made your reservations at the Hotel Colorado, Glenwood Springs, Colorado for the 1951 meeting to be held from May 28-30, write for them now. All indications are that there will be an excellent turn out for a meeting which will provide a happy opportunity for both work and play.

The Program Committee is making excellent plans for valuable contributions to the group and both the time and place will be ideal for the many relaxations available. Send your reservations to Mr. M. H. McLean, Sales and Convention Manager, Hotel Colorado, 321 C. A. Johnson Bldg., Denver, Colorado.

# Waukesha Motor

Heat treating trouble came to the Waukesha Motor Company, Waukesha, Wisconsin, recently. Several key parts for various engine models would not harden uniformly or wash easily.

A Cyanamid technical service representative was called, and came to the plant. Here he worked in close cooperation with Waukesha engineers. Combining their knowledge, they analyzed the problems . . . and found practical, effective solutions in each case with one product—AEROCARB E and W Carburizing Compounds.

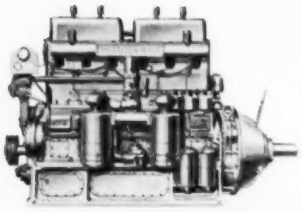
The Waukesha case is typical of the way Cyanamid service and heat treating compounds can work together to solve your metal treating problems and help you meet the high specifications required on civilian and defense contracts, so:

***Next time, call Cyanamid first.***

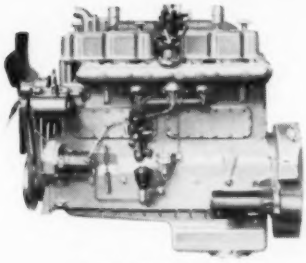
# Company dropped these problems in our lap

## and here's how AEROCARB® E and W Carburizing Compounds solved them

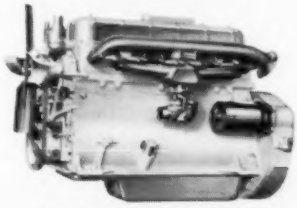
Faced with the problem of tightening specifications to improve the service life of these three key engine parts, and to make processing easier, the Cyanamid technical service representative made these recommendations:



Governor lever quadrant used in Waukesha Engine 6LRZ



Thrust plates used in Waukesha Engine 145-GKB



Starting crank jaw used in Waukesha Engine 190

A quadrant made of low carbon hot rolled steel was treated in AEROCARB E and W Carburizing Compounds at 1550° for 1¼ hours, then oil quenched. Results: longer service life due to higher and more uniform hardness, parts easily washed after treating.

Gear cover thrust plates, SAE 1314, were treated in AEROCARB E and W for two hours, then water quenched. Results: a far greater uniformity of hardness than was previously attained.

A starting crank jaw, SAE 1017 was treated in AEROCARB E and W at 1550° for two hours, then water quenched. Results: parts came clean easily and quickly in spite of the fact that the water used for quenching had a hardness of approximately 28 grains.

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☐ Please have a technical service representative call.

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*City*_____ *State*_____

# There Is Profit in Analyizing Sales As Related to Burden Rates

*By* C. G. Towne
*Porter Forge & Furnace, Inc.*
*Somerville, Mass.*

An earlier issue of "Metal Treating" contained an article by the author and Ray Sault which was entitled, "The Development of a Heat Treating Burden Rate." Burden center rates were discussed at great length and the value of knowing costs was stressed. However, the usefulness of knowing the operating cost of a particular piece of equipment goes far beyond the burden rate.

Well established burden center rates, properly used, compared with sales at the end of a month or fiscal year can show where your profit or loss is located. Which of the treatments such as tool steel hardening, high speed steel hardening, cyaniding, carburizing, normalizing, or annealing are earning their burden and labor and showing a profit? If not, why not? An analysis of sales to burden centers will give that information.

Distributing, during the month or fiscal period, the dollar value of each heat treating sale to the proper piece of equipment will show the total volume of each type of heat treating. This is a comparatively simple record to keep and can be done by the person doing the sales charging. Information of this sort kept and used properly will influence selection of new equipment, modernizing present equipment, utilization of labor, and calls of sales representatives.

At the end of each month the total number of hours a certain furnace was in operation multiplied by the burden rate gives the total burden cost for that furnace. To that is added the operator's earnings that are applicable. This may be all of his earnings or only a part depending on whether the particular equipment is automatic or semi-automatic. We then have the total burden and labor for the month. This figure subtracted from the total sales for any piece of equipment will show the gross profit or loss. From this naturally is deducted the selling and administrative expenses to find the net profit if any.

At this point the figures become influential. A careful review of the information may point out the lack of volume of a certain type of heat treating. The sales representative is advised of this deficiency and requested to concentrate on tool steel or cyanide hardening customers as the case may be. A revision of labor may be necessary. Possibly pack hardening is overloaded and the operator of the normalizing furnace has idle time. The man with idle time can then be reassigned during the slack period of the day to that center where the load is heaviest. Some may question this reassignment by stating a furnace has a maximum capacity. Often the overload is due to the preparation of the material prior to heat treating. Examples of this type of preparation are pack hardening or selective hardening or wiring for the cyanide treatment.

Analyzing the figures over a long period may show consistent top capacity and that there should be additional equipment of the same type, but that full profit is not being made. Here is where care in selection of equipment should be stressed. The additional new equipment should be the best for the heat treating process and be the most inexpensive to operate with burden and labor. Maybe the figures will tell the need of modernization.

The most important information available from an analysis of sales to burden centers is the age-old question, "Is this type of heat treating profitable?" If it is not, pricing may be inaccurate. A revision of price may be in order but certainly a continuous investigation should be made to find out why some heat treating processes are profitable and some are not.

# *Institute News . . .*

An Eastern Regional meeting of members of the Metal Treating Institute was held on February 23 at the Essex Club, Newark, N. J. The following individuals were present:

| | |
|---|---|
| Purdy Benedict | Don Knoch |
| Prieth Benedict | Herb Dobkin |
| John Benedict | Walter Rex |
| Harvey Miller | Horace Knerr |
| Frank Rizzo | Fred Heinzelman, Jr. |
| Luke Miel | Norman Hodgson |
| Al Cox | Ray Sault |
| Mike Kober | C. E. Herington |

Excellent room and luncheon arrangements were made by Purdy Benedict of Benedict-Miller and Fred Heinzelman, Jr., invited as a luncheon guest speaker, Mr. J. C. McCaghren, who is materiels and process coordinator of the New York field office of Air Materiel Command.

Mr. McCaghren gave a very interesting talk which was based primarily on answering various questions presented by those in attendance. Mr. McCaghren explained at some length the policies as established by the Air Force procurement offices and pointed out that these offices have two specific functions: product inspection and equipment and process inspection. It was pointed out that the government does not buy heat treating directly but it does have a specific interest in the heat treatment services bought by government prime and sub-contractors. He emphasized that certification by the AFPO is strictly a recognition on the part of the air materiel command that a plant's equipment is recognized as having the ability to do specific jobs. He stated also that reports resulting from equipment manufacturers' service contracts are acceptable as means of maintaining equipment approval.

Since the meeting the MTI has been successful in having the chief headquarters of the command in Wright Field standardize certain procedures as performed by all branch Air Force procurement offices.

The afternoon was devoted to discussion of the Institute's publication "Metal Treating" where it was suggested by Al Cox from Pittsburgh that the magazine's circulation be extended to cover as completely as possible, not only all commercial heat treating plants but those industrial plants who operate heat treating departments as a function of their manufacturing process. Those present agreed unanimously that this would add a great deal to the value of the magazine and President Rex and Publication Committee Chairman Horace Knerr agreed. Each member is urged to aid in the establishment of an accurate circulation list by sending in the names of those companies in their area operating heat treating departments. A total circulation of between 4,000 and 5,000 copies will be established and it will continue to be on a free basis.

Mr. Harold R. Wesley, President, Wesley Heat Treating Co., Manitowoc, Wisconsin, recently completed the installation of a new AJAX salt bath furnace. The furnace is equipped with three sets of immersed electrodes: 90 kw connected load; pot size 27" wide, 54" long and 18" deep—with operating temperatures up to 1750 degrees.

* * * *

C. F. Graham of Metal Treating Inc., Milwaukee reports that they were recently visited by A. T. Ridinger and his assistants of Metallurgical Control Laboratories, Minneapolis. They all had a nice visit and were shown through the plant.

* * * *

Wesley Steel Treating Company of Milwaukee, Wisconsin, are in the midst of a large expansion program, installing considerable new equipment. The first installation recently completed was one of a series of the new Ipsen Series "T" heat treating units, completely automatic, with a special insulated tank for martempering and controlled by an endothermic generator, atmosphere sealed and automatic processing for air cooling. Before placing the first of a series of Ipsen's in production, a delegation of top management consisting of Joseph F. Hushek, Works Manager, Harold R. Wesley, Vice President and Matt Gaus, Engineer, were driven to Chicago by William E. Bohn, General Co-ordinator, where they visited the plant of the Accurate Steel Treating Company, to see their Ipsen unit in operation.

After completing the tour in Chicago, the delegation boarded the Nickel Plate for Cleveland. While in Cleveland, they visited Bill Derhammer's plant (Lakeside Steel Improvement Co.) and other plants in Cleveland. See Letters to the Editor, Page 13.

* * * *

Joseph F. Hushek, President of Hushek Metal Processing Co., Milwaukee, has drawn plans for a specially designed flame hardening machine capable of handling gears or other parts with an outside diameter up to 36 inches. The unit will be built by the Gas Appliance Service, Inc., of Chicago, featuring gas fired ceramic burners arranged to provide instant heat at all points on the face of the gear. There will be a total of sixty burners and the unit will operate with automatic spinning of the part within a circle of high velocity gas burners and be equipped with an extra large size quenching tank automatically controlled.

The total cycle of preheating, soaking, final heating, quenching and flame drawn will require ten minutes on a 400-lb., 28-inch diameter gear. Because of the speed of gas in producing high heat it will require only two minutes to obtain desired temperatures and this will contribute materially to economical production.

This unit will be completely installed within sixty days and placed in operation at top speed production.

# THERMO-COUPLETTES . . .

## Effect of Heat Treatment on Machinability of C-1045 Steel

In a paper entitled "Machinability Measurements of Constant-Pressure Lathes" by Francis W. Boulger, Supervising Metallurgist, Battelle Memorial Institute, presented at the 19th annual meeting of the American Society of Tool Engineers, March 15-17, New York, N. Y., the author offered some interesting studies of the machinability of materials as measured by a constant-pressure lathe. Machinability being defined as the "capacity of a metal for rapid processing in a machine shop by routine procedures," he goes on to state: "In addition to composition and inclusions, microstructure can affect the machinability of steel. Tests on constant-pressure lathes often distinguish between samples, of the same steel, given slightly different heat treatments. For instance, a C1045 steel was tested in the hot-rolled condition and after heating for one hour at 1600°F and cooling in air. The micrographs . . . show that the grain size of the steel was smaller after heat treatment. This change in microstructure was accompanied by a decrease in machinability as measured by constant-pressure tests. The machinability ratings, based on a B1112 steel as 100, were 58 for the hot-rolled condition and 51 after heat treatment. Both ratings are in the normal range for the grade, but the difference is large enough to be important."

Data obtained on a series of similar steels are summarized in Table 1. All steels met the chemical and other specifications for the grade. The data are interesting, because the machinability ratings varied considerably in the as-received condition and could be changed by heat treatment.

A medium-coarse grain size seems to be desirable for easy machining of these C1045 steels. Heat treatments which coarsened the actual grain size of Steels "4," "5," and "10" resulted in better machinability ratings. Heat treatments which produced finer actual grain sizes lowered the machinability ratings of Steels "6" and "7." However, the results on "9" and comparisons between the others show that the size of the "pearlite grains" does not correlate perfectly with the machinability ratings. Machinability ratings are apparently influenced by more subtle differences in microstructure. For example, air cooling from 1850°F improved the machinability ratings of another grade of 0.45% carbon steel regardless of the change in grain size.

Table 1 also shows that the machinability ratings in constant-pressure tests were not influenced very much by hardness. The ratings of Steels "6," "7," and "14" were lowered by heat treatments which resulted in lower hardnesses. In other cases, the machinability ratings varied appreciably although the hardness was not affected. Steel "14" had a remarkably poor machinability rating in the spheroidized condition. This seems to be true for C1045 steels, although spheroidization treatments benefit alloy and higher carbon grades.

TABLE 1—EFFECT OF HEAT TREATMENT ON CONSTANT-PRESSURE MACHINABILITY RATINGS OF C1045 STEEL

| Steel Number | Condition[1] | Vickers Hardness | Pearlite Grain Size (ASTM) | Constant-Pressure Machinability Rating[2] |
|---|---|---|---|---|
| 14 | As received | 219 | 2-3 | 56 |
| | Spheroidized | 156 | — | 32 |
| 6 | As received | 237 | 0-1 | 55 |
| | Heat treated | 195 | 7 | 45 |
| 7 | As received | 236 | 2 | 52 |
| | Heat treated | 186 | 6 | 44 |
| 4 | As received | 193 | 4 | 42 |
| | Heat treated | 191 | 1-4 | 52 |
| 10 | As received | 200 | 6 | 41 |
| | Heat treated | 209 | 0-5 | 49 |
| 5 | As received | 188 | 4 | 40 |
| | Heat treated | 203 | 1 | 56 |
| 9 | As received | 204 | 6 | 40 |
| | Heat treated | 202 | 7 | 47 |

(1) *Heat Treatments:* Samples of Steels 6 and 7 were held ½ hour at 1550°F and furnace cooled to produce a finer grain size. Samples of Steels 4, 5, and 10 were air cooled after one hour at 1850°F to produce a coarser grain size. Steel 9 was heated one hour at 1750°F and air cooled. The heat treatment produced a finer grain size and wider ferrite boundaries than the original microstructure.

(2) The performance of Steel 6 in the as-received condition was used as the standard of comparison. That sample was given an arbitrary rating of 55: lower ratings indicate inferior machinability. On the ASTM scale, higher numbers indicate smaller grain sizes.

## New Multipoint Capacilog

Wheelco Instruments Company, 847 W. Harrison Street, Chicago, is now in production on a new Multipoint Capacilog (see cut).

The electronically operated unit is a deflection type strip chart recorder which provides up to six permanent records on one chart. Measurement may be obtained with sensing units producing electric signals, such as thermocouples, radiation detectors, etc.

This deflection type system is a direct reading, nonbalancing method of detecting changes in a measured variable which achieves results heretofore obtainable only through the use of potentiometric or null type systems.

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| 125 | 275 | 450 | 1000 | 1550 |
| 138 | 288 | 500 | 1050 | 1600 |
| 150 | 300 | 550 | 1100 | 1650 |
| 163 | 313 | 600 | 1150 | 1700 |
| 175 | 325 | 650 | 1200 | 1750 |
| 188 | 338 | 700 | 1250 | 1800 |
| 200 | 350 | 750 | 1300 | 1850 |
| 213 | 363 | 800 | 1350 | 1900 |
| 225 | 375 | 850 | 1400 | 1950 |
| 238 | 388 | 900 | 1450 | 2000 |

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# LETTERS TO THE EDITOR

*Dear Editor:*

I have been meaning to drop you a line every day since I received your card in regard to sending in personals for the column in "Metal Treating." However, like the rest of the fellows in our line, I am good at postponing things.

At any rate, the first thing I want to do is to congratulate you on the fine release in regard to the MRO order established by the NPA. Our company subscribes to several services which are supposed to keep us up to date on all Government orders and restrictions, but to date we have heard nothing from them on this MRO order. Again, thanks and congratulations.

Now for some items you might be able to use for your personal column. On February 16th the Midwest Chapter of the Metal Treating Institute held their second meeting of the year. We had quite a good turn-out with the following men and companies being present:

Accurate Steel Treating, Chicago—Walter Hamilton, Jr.
American Steel Treating, Chicago—Henry E. Cooke, Jr.
Chicago Steel Treating, Chicago—Bob Seger, Andy Olson
Dura-Hard Steel Treating, Chicago—Mr. Ciske
Eklund Metal Treating, Rockford—Art Eklund
Harris Metal Treating, Racine—George Harris, Joe Devorney
Hushek Metal Treating, Milwaukee—Bill Boehm
Lindberg Steel Treating, Chicago—Roy Lindberg, Ken Jenks, Arney Uitti
Metal Treating, Inc., Milwaukee—Clarence Graham
Pearson Industrial Steel Treating, Chicago—L. P. Josephs, Mr. Bocik
Perfection Tool & Metal Heat Treating, Chicago—Bob Davis
Spindler Metal Treating, Racine—Roy Spindler
Wesley Steel Treating, Milwaukee—Charles Wesley
Wesley Metal Treating, Racine Melvin F. Kesting
Wesley Heat Treating, Manitowoc—Harold Wesley
Fred A. Snow Co., Chicago—Clinton Snow

One of the first things mentioned at the meeting was the fact that Rudy Thurner of Thurner Heat Treating, Milwaukee, had been in the hospital. However, Clarence Graham mentioned that Rudy was much improved and was now at home.

The majority of the evening was spent discussing the various problems confronting our industry today. Of course high on this list was the problem of obtaining DO ratings, extending them, etc. Also the question of wages.

Another problem that was discussed was the hiring or retaining of an outside metallurgist. This is a good deal along the lines that were discussed at the Fall Meeting. One of the Midwest members has retained Prof. Dowdell of the University of Minnesota to represent him in a current problem. However, the case was not completed at the time of our meeting but the results will be given at our next meeting.

I trust that you might find something of interest in the above.

Yours very truly,
Perfection Tool & Metal
Heat Treating Co.
Bob Davis

*Dear Editor:*

The postcard did it!

Called Bob Davis of Perfection who is Secretary of the Midwest Chapter and he will send you the "scuttle-but" on our meeting of February 16th.

Understand that John Hulting, President of Perfection Tool & Metal Heat Treating Co. is spending the entire winter at his home in Florida. Walter Hamilton, President of Accurate Steel Treating is also having an extended vacation in the same state.

H. G. Magnussen, V. P. of Lindberg Steel Treating too has motored to Florida for a few weeks of golf and fishing.

George Harris of Harris Metal Treating Co., Racine, Wisconsin flew his privately owned plane to Florida on Saturday, February 24th. He intended to spend a

week of deep-sea fishing in the Gulf of Mexico.

Business is of course good—our streets, sidewalks and alleys are again cluttered up with skids of material—expect a call from the Alderman or Mayor of Chicago any day.

Will try to keep this up—and more so. No steno available today.

Lindberg Steel Treating Co.
Roy Lindberg

*Dear Editor:*

I was greatly surprised and honored by a visit from Joe Hushek, Harold R. Wesley (Charlie's son), and Matt Gaus of Wesley Steel Treating Co. on an inspection tour through our plant on Thursday, February 22nd. It is always our policy to welcome an open shop to all MTI members from near and far. We never consider we have any competitors, just another heat treater.

Bob took them to the George H. Porter Steel Treating Co. and General Metal Heat Treating, Inc., where they were also favorably impressed. However, as their time was limited, they didn't get a chance to get around to see any other plants.

Charlie Wesley, as a few members will recall, was the originator of a long and delightful "barnstorming" trip in the NRA days which covered Milwaukee, Chicago, Cleveland, Boston, Newark, New York City, Pittsburgh and Cincinnati, visiting all the MTI members' plants. There was never a dull moment on this trip and I enjoyed it immensely, and believe it brought together a closer acquaintance of commercial steel treaters than anything that could have happened. The exchange of ideas and relaxation were what I think kept the organization together, and I wish someone would start it again.

As you are desirous of news items for the next Metal Treating publication, we thought perhaps this might be of interest. Kindest regards,

Very truly yours,
The Lakeside Steel
Improvement Co.
C. W. Derhammer


for
information
on
metal treating...

turn to the pages of

**Materials & Methods**

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# Manufacturers' Literature . . .

*The literature listed below contains information of interest to heat treating organizations. For your copy write direct to the manufacturer and be sure you mention seeing it reviewed in "Metal Treating".*

### An Important New Defense Production Bulletin

A new and comprehensive 8-page bulletin on heating and heat treating equipment for defense production has just been issued by Surface Combustion Corporation. The bulletin, entitled " 'Surface' Heating and Heat Treating Furnaces for Defense Production," covers heating for forging as well as heat treatments to develop the required properties for the production of all kinds of ordnance material. Among the items covered are ammunition, guns, tanks, aircraft and ships. The production of engines, power transmission equipment, as well as tools and special parts, is also included.

Copies may be obtained by writing to Surface Combustion Corporation, Toledo, Ohio, and asking for Bulletin SC-150.

* * * *

### New Edition of Bristol Thermocouple and Pyrometer Accessories Catalog

The Bristol Company of Waterbury, Conn., has just published a new edition of its thermocouple and pyrometer accessories bulletin, listing many additional items and containing new data on the proper application and use of thermocouples. The new 56-page bulletin contains a well illustrated catalog of hundreds of pyrometer supply items, including assembled thermocouples, thermocouple wires, extension wires, protection tubes, insulators, and accessories for the full range of industrial pyrometer applications.

New technical information and installation sketches have been added to the "Users' Manual" section, which contains engineering data on modern practices in pyrometry. Also included are tables of calibration data for the commonly-used base metal and rare metal thermocouples. The new edition of this bulletin, No. P1238 is available from the Bristol Company.

* * * *

### Wheelco Capacilog

Bulletin C2-2 describing the Wheelco Capacilog line of electronically operated strip chart recorders has just been released. In addition to explaining how Direct Deflection, Wheatstone Bridge Circuit and Pneumatic Control types of operating systems are applied to Capacilogs, the bulletin also lists model numbers and specifications of the various recorders and recorder-controllers. A separate price list supplements the bulletin.

Copies of bulletin and price list are available upon request to Wheelco Instruments Company, 847 W. Harrison St., Chicago 7, Illinois.

### Shaker Hearth Furnace

Bulletin HD-850 describes the shaker hearth furnace manufactured by Hevi Duty Electric Company, Milwaukee 1, Wisconsin for bright carburizing, cyaniding and hardening operations. The four-page booklet is well illustrated and in addition to specifications illustrates a number of examples of typical work which the furnace is capable of handling.

* * * *

### Alloy Tool and Die Steel Property Comparisons

Latrobe Electric Steel Company, Latrobe, Pa. has prepared a data sheet providing comparative property analysis and application data for a variety of die steels of their manufacture. The company also offers to provide complete heat treating data on all brands described.

* * * *

### Rust Prevention and Removal

Western Reserve Laboratories, 1438 St. Clair Ave., Cleveland 14, Ohio, announces the development of a new product said to combine chemically with many metal surfaces to form a rust inhibiting coating. It is also stated that material tightly bonds paint or lacquer to metal. Further information upon request.

* * * *

### 715 and 720 Manganese Age Hardening Alloys

New age hardening alloys have been developed by General Plate, a division of Metals & Controls Corporation of Attleboro, Mass. The alloys have many industrial and jewelry applications. High strength and elastic limits are said to be attained with little or no distortion during the hardening. The high physical properties have resulted in 715 and 720 being used for springs, diaphragms, clips and small parts of intricate shape. The annealing, age hardening and protective atmosphere recommended for heat treatment are thoroughly covered in Bulletin No. 705A which can be obtained by writing to the above company.

* * * *

### Small Shop All-Purpose Furnace

A one-page mailing piece describes the all-purpose small heating furnace manufactured by Monogram Products Company, 731 North 35th Street, Philadelphia, Pa. Chamber sizes range from 7 x 7 x 12 up to 12 x 12 x 24, with control temperatures possible up to 2000°F.

**ASTE Elects New President**

J. J. Demuth, member of the Executive Committee and General Superintendent of Sligo, Inc., St. Louis, Mo., has been elected President of the American Society of Tool Engineers.

In the ASTE, Demuth served as Chairman of the St. Louis Chapter in 1946-7 and as a Director of the National Society since 1948. During 1949-50 he was 1st Vice-President of the ASTE.

## PERSONALS

Ray G. Sault has been elected President of Porter Forge & Furnace, Inc., Somerville, Mass., and A. F. Sherys has been appointed Vice President.

These changes were brought about by the unfortunate and untimely death in February, 1951, of Mr. H. W. Porter, former President.

Both Mr. Sault and Mr. Sherys will continue to retain their positions as General Manager and Superintendent respectively.

* * * *

Conrad H. Knerr of Metlab Co., Philadelphia, was married February 10 to Miss Shirley Ketcham of Chestnut Hill, Philadelphia. They spent their honeymoon skiing in Canada.

* * * *

Mr. and Mrs. Fred Heinzelman, Sr. have recently returned from a vacation in Florida. Accompanying them was Mrs. Heinzelman's uncle who is visiting America from Germany and Mr. Heinzelman's youngest niece from his hometown in Switzerland.

> How little my countrymen know what precious blessings they are in possession of and which no other people on earth enjoy.
>
> THOMAS JEFFERSON

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Ohio Heat Treating Co.
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Perfection Tool & Metal Heat Treating Co.
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Chicago 22, Illinois

Pittsburgh Commercial Heat Treating Co.
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Porter Forge & Furnace, Inc.
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Somerville 43, Massachusetts

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Milwaukee 14, Wisconsin

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1223 Burnet Avenue
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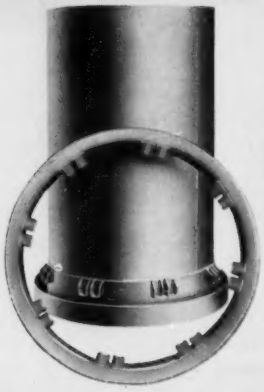
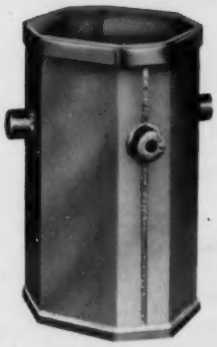


Welded alloy retort for gas carburizing furnaces. Serving 10,000 hours.



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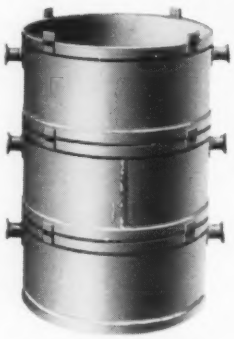
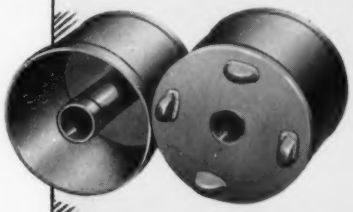


Right above— these chimney type boxes for carburizing ring gears are made in any size.



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